

ANALYSIS OF SECTION V.

I. Periodical Winds.

1. MONSOONS.
 - a. Definition, direction, and cause.
 - b. Monsoons of Indian Ocean explained. Transition.
 - c. Minor monsoon belts. Position and character.

2. LAND AND SEA BREEZES.

- a. Where occurring and why.
- b. Daily alternation of temperature within the tropics.
- c. Sea breeze, when and how caused. Land breeze.
- d. Inland diurnal breezes.

3. LOCAL PERIODICAL WINDS.

- a. Desert winds. Names and character. Directions.
- When and how occurring. Effects.
- b. Etesian Winds. Northerns.

II. Zone of Variable Winds.

1. PREVAILING CURRENTS.

- a. Character of winds in this zone.
- b. Normal currents of this zone.
- c. Effect of juxtaposition and opposite directions.
- d. Character of other winds.

2. SUCCESSION OF WINDS.

- a. Law of rotation signifies what. By whom discovered.
- b. Order of displacement in northern hemisphere.
- c. Order of displacement in southern hemisphere.
- d. Effects of transition how manifested.

3. STARTING POINT OF POLAR WINDS.

- a. Effect of expansion of lands in northern regions.
- b. Atmosphere of northern lands in winter.
- c. Motion of cold, heavy air.
- d. Direction of winds in eastern Asia and North America.
- e. Direction of winds in western Asia and Europe.
- f. Effect of approach of current to equator.
- g. Exception in North America.

4. SWEEP OF PREVAILING CURRENTS.

- a. Path of polar winds.
- b. Path of return trades.
- c. Effect on comparative temperature of continents and oceans.
- d. Dominant winds in different seasons.
- e. Period of displacement.
- f. Effect of final establishment of either current.
- g. Effect of unusual prolongation of either.

VI.—REVOLVING STORMS.

I. Introduction.

When currents of air, moving in different directions, encounter each other, they produce a rotary motion in the atmosphere, such as is seen in the small whirlwinds which often lift up the dust of our streets in summer. Such a movement on a grand scale is a revolving storm or *cyclone*,¹ to which various local names are given. When the conflicting currents of air are of very different temperatures, these storms are usually accompanied by the condensation of vapor, producing rain, snow, or hail, and not infrequently by vivid electrical discharges.

Cyclones vary in the nature and violence of their phenomena, according to their immediate cause. The most remarkable for violence, and for the regularity of their course, are the *hurricanes* of the West Indies, and of

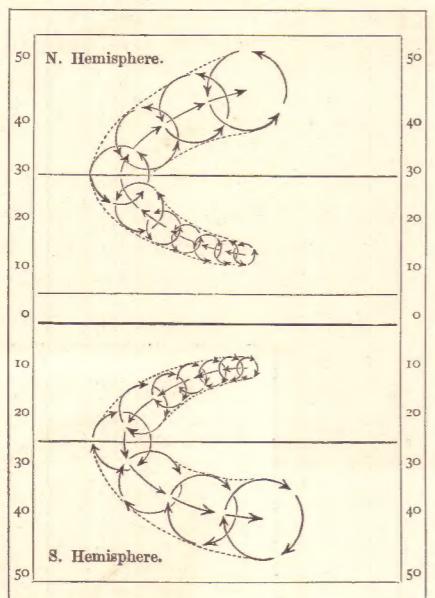


FIG. 33. COURSE OF CYCLONES.

¹ From the Greek *kuklos*, a circle.

Mauritius in the Indian Ocean; the *typhoons* of the South China Sea; and the *cyclones* of the Gulf of Bengal.

The peculiar position of these great cyclone regions of the globe, at the southeast of the largest continents and under the tropics, seems to indicate that these storms are the result of a conflict, in the upper air, between the general winds of the temperate and tropical zones, intensified by the disturbing influence of the great land masses.

II. Law of Storms.

1. MOTIONS. Observations upon the winds and the pressure of the air, during cyclones, have been collected with great care and industry by Mr. Redfield of New York, Governor Reid of Bermuda, Piddington of Calcutta, and Professor Dove of Germany. They all go to prove that, in these storms, the air rotates with great velocity, around a centre where calm prevails and the barometric pressure is least.

Everywhere, on opposite sides of this centre, the wind blows from opposite directions; while the storm itself has a rapid progressive motion, and always advances from lower to higher latitudes.

In the *northern hemisphere* the rotary motion is from right to left, or contrary to that of the hands of a watch; while the progressive motion, within the zone of trades, is towards the northwest, and beyond that zone, towards the northeast. (See Fig. 33.)

In the *southern hemisphere* the rotary motion is from left to right; the progressive, in the zone of trades, is towards the southwest, and beyond that limit, towards the southeast.

The progressive motion, therefore, diverges slightly from the direction of the trade-winds within their limits, and follows that of the return-trades in the zone of variable winds. Hence it would seem to be connected with the general currents of the atmosphere.

2. ORIGIN AND PROGRESS. The cyclones usually begin within the tropics, but extend far into the temperate regions, where they gradually spend their force. The *West India cyclones*, called *hurricanes* (See *Map of Winds*), generally originate in the eastern Antilles, moving northwestwardly to the coast of Florida. About the limit of the trades, they turn nearly at a right angle, and sweep over the eastern coast of North America and the adjacent waters of the Atlantic; then crossing the ocean, they reach western Europe, beyond which they finally expire.

the Mediterranean shores, from the southeast, south, and southwest; in Syria, from the south and southeast; and in Arabia, from the interior towards all points of the compass. The *Sirocco*, advancing across the Mediterranean, is felt in Sicily and Italy; and is known in southern Spain as the *Solano* or *Levanter*.

The name, *Khamsin*, meaning fifty, indicates the length of the season,—about fifty days, including the month of May and a part of April and June,—during which this wind may blow. *Simoom* means hot as well as poisonous.

These desert winds are not continuous, but occur at intervals during the two or three months of greatest heat, lasting from one to fifteen days at a time. They usually blow in successive blasts, which differ in temperature, sometimes by more than 20° Fahr., and alternate with great rapidity. Dry, laden with the impalpable dust of the desert, and subject to such rapid alternations of temperature, they are exceedingly oppressive and exhausting to the human system, and not infrequently cause death by prostration.

The *Etesian Winds* are northeasterly and easterly winds which blow, during the latter part of summer, over Greece, the Archipelago, and the Mediterranean, towards the continent of Africa. They commence near the middle of July, when the heat is greatest, and continue until September, blowing only in the day-time.

The *Northerns* of Texas are violent, cold, dry winds, which descend from the upper air, and occur chiefly in winter. They sweep over Texas, Louisiana, and the table-lands of Mexico, sometimes carrying their cold blasts even to the Antilles, where they present a striking contrast to the gentle and genial trade winds.

II. Zone of Variable, or Alternating Equatorial and Polar, Winds.

1. PREVAILING CURRENTS. Within this zone, which extends from the vicinity of the tropics to the polar circles, the winds are not periodical, but blow during the year from every quarter of the horizon, without apparent order. Two general currents, however, the polar winds and the return-trades, predominate to such an extent that they may be considered the prevailing, or *normal currents*, of these latitudes.

Differing in temperature, and flowing side by side, or one above the other, but in opposite directions, they constantly encounter each other and struggle for the mastery. Their conflicts produce the frequent storms which characterize these zones; and the displacement of the one by the other always involves a marked change of weather. The return-trade brings heat, and clouds or rain; but the polar winds bring cold, dry weather, a bracing air, and a clear sunny sky.

The other winds blowing in these zones are either the transition winds, which occur during the displacement of one current by the other; or are the result of the deflection of these normal currents, by mountain ranges or other peculiarities of the continental reliefs.

2. SUCCESSION OF WINDS. The return-trades and the polar winds usually displace each other in an order indicated by Prof. Dove, and called by him the *law of the rotation of the winds*. This order of succession must not be confounded with the veering of the wind from point to point in a revolving storm, which has a different origin. (See *Revolving Storms*, page 82.)

In the *northern hemisphere*, generally, when the return-trade is displaced by the polar current, the wind blows successively from the west, the northwest, and the north, and settles in the northeast. In eastern North America, however, it settles in the northwest. (See Topic 3, below.) When the polar wind is displaced by the return-trade, the successive changes are to the east, southeast, south, and finally to the southwest. (See diagram in *Map of Winds*.)

In the *southern hemisphere* the order of transition is reversed, as is also the character of the currents. The northwest wind is the

warm, moist return-trade; while the southeast is the cold, dry polar wind. The transition is from the northwest by the west, southwest and south to the southeast; and from the southeast by the east, northeast, and north, to the northwest.

The effect of the transition of the winds is manifest, both in the density and the temperature of the air. When the return-trade blows, the air being warm, moist and light, the thermometer is high and the barometer low. When it is displaced by the polar current, the thermometer falls and the barometer rises.

3. THE STARTING POINTS OF THE POLAR WINDS are in the centres of lowest temperature, on the Arctic shores of Asia and North America. (See *Map of Temperature*, pages 74, 75.)

The expansion of these two continents at the north is such that a great extent of land lies in the immediate vicinity of the Arctic circle. This large area of Arctic land, combined with the long nights of a winter lasting nearly or quite half the year, converts the northern regions of Asia and North America into vast refrigerators, where the atmosphere, during the northern winter, is reduced to its minimum temperature and its greatest density.

From here the *cold, heavy air* presses towards the oceans at the east and the west, and the more southerly warm lands. Hence *Eastern Asia* and *North America*, especially in high latitudes, receive their coldest winds from the northwest; while *Western Asia* and *Europe* receive them from the northeast.

As the *cold air advances towards the equator*, and falls increasingly under the influence of the Earth's rotary motion, it tends more and more to become everywhere a northeast wind. But in *North America* the great barrier of the Rocky Mountains, which is highest in the middle latitudes, turns it out of its southwesterly course, and deflects it towards the southeast; hence throughout our Atlantic seaboard, even to the sub-tropical regions, the cold, dry winds are from the northwest.

This exceptional direction of the polar winds in eastern North America, is shown on the *Map of the Winds*.

As the *sun advances northward* in the spring, his genial beams impart a constantly growing warmth to the Arctic lands; and the rapidly increasing length of the days accelerates the change from a low to a high temperature. Thus the fountains of the cold winds are gradually dried up; the pressure of the northern air is diminished; and, during the summer, the warm gentle return-trades have almost undisputed sway nearly to the Arctic circle.

4. RANGE AND EFFECTS. The *polar currents*, having their origin in the Arctic lands, take their course, in general, over the surface of the continents, while the *return-trades* prevail upon the oceans. This fact accounts for the low average temperature of the interior of the continents, in middle latitudes, in comparison with that of the oceans, as indicated by the isothermal lines.

In the middle and northern portions of the zone of variable winds, the return-trades are the *dominant winds* during the summer, the polar winds during the winter. The *period of transition*, occupying several weeks following the equinoxes, is one of almost incessant conflict; hence the severe storms, and frequent changes of wind and weather which characterize those seasons of the year.

The *final establishment* of the return-trade, with its genial temperature and fertilizing showers, ushers in the summer; its final retreat before the polar winds, toward the close of the year, opens the winter. The *continuance* of the return-trade beyond its average time of displacement produces a "late autumn," and that of the polar winds, a "late spring."